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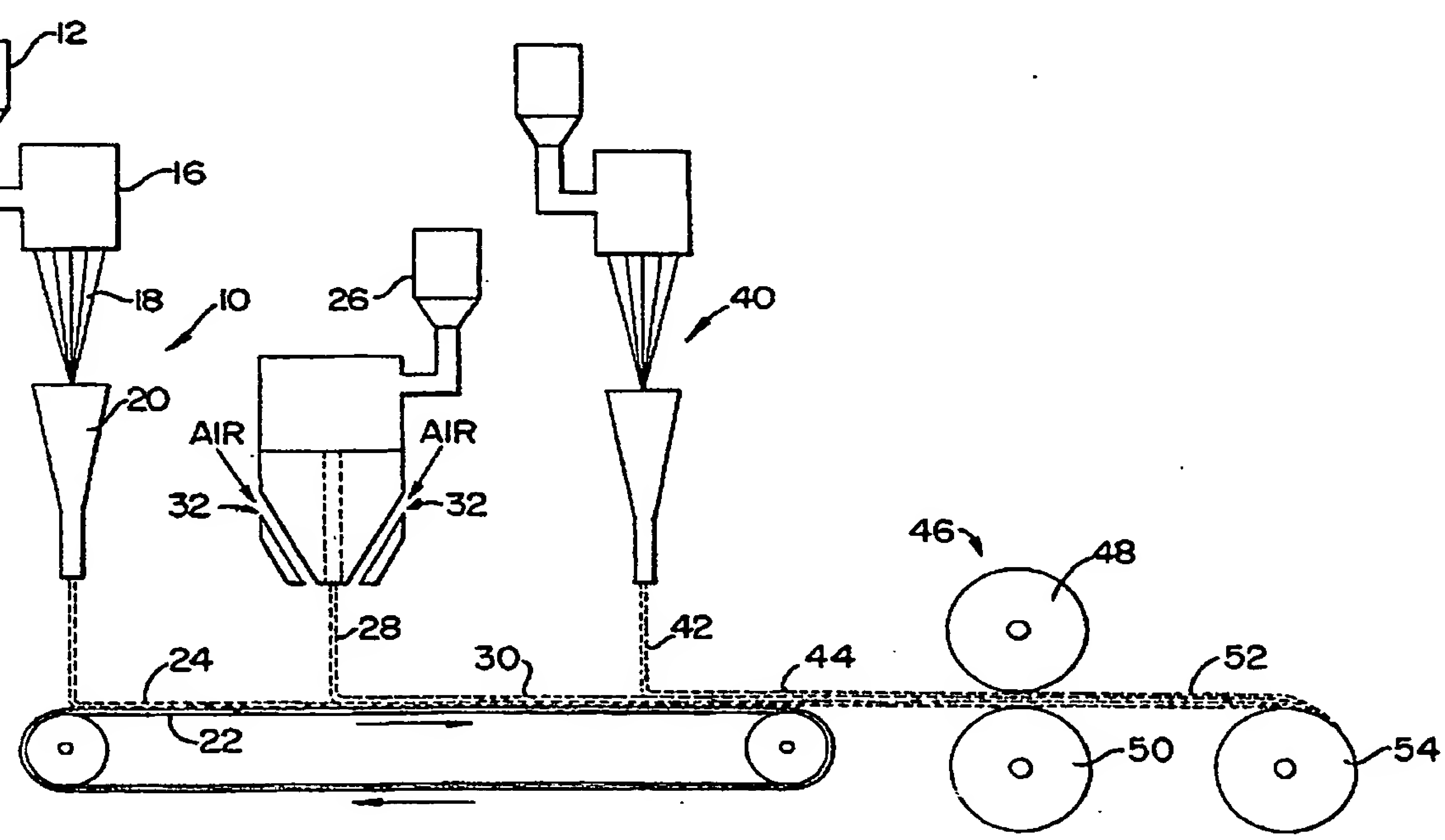

(57) Abstract

The invention provides composite elastic nonwoven fabrics and the process of making them. The elastic nonwoven composite fabrics of the invention are formed from the combination of a plurality of cooperative elastic layers including an elastomeric meltblown web and an elastomeric spunbonded web. The elastomeric layers are joined together in unitary elastic fabric structure to provide a composite having a desirable combination of elastic and barrier properties.

COMPOSITE ELASTIC NONWOVEN FABRIC

Cross Reference to Related Applications

This application is a continuation-in-part application of U.S. Patent Application Serial No. 07/829,923 of Gessner, et al., filed February 3, 1992, entitled "Elastic Nonwoven Webs and Method of Making Same."

Field of the Invention

The invention relates to composite elastic nonwoven fabrics and to processes for producing them. More specifically, the invention relates to elastic nonwovens having desirable conformability, aesthetic, barrier, and extensibility properties, and which can be readily manufactured using existing textile equipment.

Background of the Invention

Elastic fabrics are desirable for use in bandaging materials, garments, diapers, supportive clothing and personal hygiene products because of their ability to conform to irregular shapes and to allow more freedom of body movement than fabrics with limited extensibility. Elastomeric materials have been incorporated into various fabric structures to provide stretchable fabrics. In many instances, such as where the fabrics are made by knitting or weaving, there is a relatively high cost associated with the fabric. In cases where the fabrics are made using nonwoven technologies, the fabrics can suffer from insufficient

strength and/or only limited stretch and recovery properties.

Elastomeric nonwoven fabrics have been prepared, for example, by meltblowing an elastomeric polymer. However, the meltblowing process is normally conducted using relatively low molecular weight, and relatively high melt flow rate polymers. In addition, meltblown fibers are relatively unoriented. As a result, meltblown elastomeric webs are only moderately strong. For similar reasons, elastomeric meltblown webs are only moderately elastic. These deficiencies in elasticity can be seen in relatively high creep, i.e., the time dependent increase in elongation when the web is subjected constant stress; and also in relatively high stress relaxation, i.e., the time dependent loss of retractive power when the web is held in a stretched condition.

Low strength is objectionable because low strength elastic fabrics are apt to tear when stretched significantly. Creep and stress relaxation properties are also highly significant. For example, in elastic garments, personal hygiene products, diapers, and other products intended to conform to various body parts, high creep and stress relaxation properties can result in the loss of conformability and elastic recovery during use of the product. This is particularly true when the product is stretched significantly and/or stretched and heated during use, as can happen when stretched products are contacted with body fluids.

Many elastomeric nonwoven fabrics also suffer from poor aesthetics. Elastomers often have an undesirable rubbery feel. As a result, elastomeric nonwoven fabrics often have a hand and texture that is perceived by the user as sticky or rubbery and therefore undesirable.

Due in part to the shortcomings in strength, elasticity, and aesthetics, substantial effort has been

directed to the formation of composite elastic nonwovens by combining elastomeric nonwoven fabrics with other fabrics. These include fabrics having a more desirable hand for improving aesthetics of the elastomeric nonwoven, and fabrics having greater strength for protecting the elastomeric nonwoven from being overly stretched to a condition where elastic properties or fabric integrity are lost.

U.S. Patent 4,775,579 to Hagy, et al. discloses desirable composite elastic nonwoven fabrics containing staple textile fibers intimately hydroentangled with an elastic web or an elastic net. The resulting composite fabric exhibits characteristics comparable to those of knit textile cloth and possesses superior softness and extensibility properties. The rubbery feel traditionally associated with elastomeric materials can be minimized or eliminated in these fabrics.

U.S. 4,413,623 to Pieniak discloses a laminated structure such as a disposable diaper which can incorporate an elastic net into portions of the structure. The elastic net can be inserted in a stretched condition between first and second layers of the structure and bonded to the layers while in the stretched condition. Subsequent relaxation of the elastic net can result in gathering of the structure.

U.S. 4,525,407 to Ness discloses elastic fabrics which include an elastic member, which may be an elastic net, intermittently bonded to a substrate which prior to stretching is less easily extensible than the elastic member. The nonelastic member is bonded to the elastic member and the entire composite is rendered elastic by stretching and relaxation.

U.S. 4,606,964 to Wideman discloses a bulked composite web which can be prepared by bonding a gatherable web to a differentially stretched elastic net. Subsequent relaxation of the differentially

stretched net is said to result in gathering of the fabric.

U.S. 4,720,415 to Vander Wielen et al. discloses an elastic laminate wherein an elastomeric meltblown web is stretched and bonded to non-elastic layers while in the stretched condition. Subsequent relaxation of the composite results in a gathered composite.

The processes for manufacturing these laminates suffer from various disadvantages. The lamination of webs and nets formed from thermoplastic elastomers to other fabrics under tension can be extremely difficult. Small changes in tension during manufacture can result in stretching or recovery of the fabric which can lead to a non-uniformly manufactured product. This is particularly true when heating is required, for example, during adhesive application, lamination, thermal bonding or other thermal treatment. In addition, thermoplastic elastomers can lose elastic properties when stressed at elevated temperatures and allowed to cool fully or partially while stressed.

Moreover, when relaxation with concomitant gathering is used as the basis for stretch in the final composite, the resultant fabric often has an excessive thickness which can also be aesthetically objectionable. And in many instances, the final fabric exhibits a low extensibility which is well below the possible extensibility afforded by the elastomeric component.

Laminated nonwoven fabrics which have no elastic properties are also widely used in a variety of everyday applications, for example, as components in absorbent products such as disposable diapers, adult incontinence pads, and sanitary napkins; in medical applications such as surgical gowns, surgical drapes, and sterilization wraps; and in numerous other

applications such as disposable wipes, industrial garments, housewrap, carpets, and filtration media.

Nonwoven fabric laminates based, in part, on meltblown webs have found use in barrier applications for preventing penetration by liquids, microorganisms and other contaminants. The meltblowing process can form very small diameter fibers that are entangled sufficiently to provide a fibrous web which, although porous and breathable, is impervious to liquids, bacteria or other contaminants. However, because meltblown webs are not high strength fabrics, as discussed previously, barrier fabric laminates of this type typically include one or more reinforcing fabric layers combined with the meltblown web.

Spunbonded webs have been used to reinforce meltblown webs. For example, the meltblown web can be sandwiched between outer spunbonded web layers because spunbonded webs are not only stronger than meltblown webs, but are also more abrasion resistant. Thus, the meltblown web within the sandwich structure is protected both against excessive tensile stresses and also against contact with excessively abrasive surfaces. Fabrics of this type are used as medical and industrial garments, CSR wraps, surgical drape and housewrap. Specific examples of such fabrics are described in U.S. Patent Nos. 3,676,242; 3,795,771; 4,041,203; 4,766,029; and 4,863,785.

Even though composite nonwoven fabric laminates of this general type have found widespread use in various applications, these fabrics can have certain undesirable aesthetic properties including poor drapeability and softness. Typically, these nonwoven fabric laminates are stiff or "boardy", and resist bending and folding. Accordingly when these fabrics are used as a component in a garment, such as a disposable absorbent product, the garment resists conforming about the body's shape, and can wrinkle,

leaving gaps between the wearer's skin and the product. When used in sterilization wrap applications, these fabrics often resist folding with the result that the wrapped fabric will try to unfold back into a flat sheet after having been wrapped around an object.

Although the stiffness and hand of these barrier fabrics can be improved by modifying the spunbonded layers, care must be exercised not to unduly weaken the spunbonded layers. Otherwise the protection afforded the interior meltblown layer can be lost with an accompanying loss of barrier properties.

Summary of the Invention

The invention provides elastic nonwoven laminate fabrics which have pleasing aesthetic properties, such as desirable hand and cover, flexibility and drape. The elastic nonwoven composite fabrics of the invention are formed from the combination of a plurality of elastomeric layers including an elastomeric spunbonded web and an elastomeric meltblown web. The plural elastomeric layers are joined together into a unitary coherent elastic fabric structure to provide a composite having a desirable combination of properties. The elastomeric meltblown layer imparts desirable barrier and/or porosity properties to the laminate structure, while the elastomeric spunbonded web imparts good aesthetics, drapeability, and durability to the composite.

Because each of the individual layers are elastic, the composite as a whole is extensible, and thus conformable about irregular shapes. Thus the fabric does not exhibit the stiffness associated with typical laminate products. However, although elastic and thus extensible, the composite fabrics still maintain desirable barrier and/or porosity properties, preventing penetration of the laminate by air borne particulates, fluids, and the like depending upon the desired end use. Additionally in some instances, under

conditions of low stretch, the laminates of the invention can serve as barriers to selected microorganisms.

The composite also exhibits good strength properties not previously available from elastic meltblowns used alone, which previously have been subject to tearing and/or rupture when subjected to significant forces, or have been reinforced with other materials which significantly limit extensibility and often greatly increase fabric thickness. In addition, nonwoven composites of the invention have stretch in both directions, with no need to laminate additional materials of low extensibility. Preferred elastomeric spunbonded webs used in the composite fabrics of the invention have substantial strength and durability, yet also provide a soft, aesthetically pleasing hand that is significantly improved as compared to prior art laminates employing polypropylene spunbonded webs. Further, because the component layers used to form the composites of the invention are elastic structures, no stretching and subsequent relaxation are required to impart elastic properties to the composite. This simplifies the lamination process while also minimizing thickness of the elastic composite.

Each of the individual laminate layers can be formed of the same or different elastomeric polymers, and thus can exhibit the same or different properties, as desired for a particular end use application of the laminate. For example, the meltblown web can be formed of an elastomeric polymer having good elastic properties, such as good elongation and recovery. The meltblown web can then be joined to an elastomeric spunbonded web formed of a softer and less elastic polymer, which can impart good hand to the composite, while still supporting extension and thus conformability of the composite. In addition, the laminates of the invention can employ spunbonded layers

having a high coefficient of friction to provide articles for use in skid resistant applications, such as shoe coverings.

In one preferred embodiment of the invention, at least one elastomeric meltblown web is sandwiched between two outer elastomeric spunbonded webs. The webs are joined together thermally or adhesively to form a composite spunbonded/meltblown/spunbonded laminate fabric. The resulting composite has the desirable barrier and/or porosity properties of an elastomeric meltblown web, and at the same time exhibits good hand, softness, and durability from the elastomeric spunbonded webs. As noted above, because each of the individual layers of the composite are elastic, the laminate as a whole is extensible and conformable, in contrast to typical laminate products which suffer from stiffness and inflexibility.

The composite nonwoven elastic spunbonded/elastic meltblown fabrics of the invention can be manufactured by relatively simple and straightforward manufacturing processes which involve forming at least one elastomeric meltblown layer directly on a spunbonded web. The elastomeric spunbond web or webs can be joined to the elastomeric meltblown web by a thermal or adhesive bonding process. Preferably, joining of the elastomeric meltblown web and spunbond elastomeric layers is accomplished by point bonding using heat and pressure with a calender.

The composite elastic fabrics of the invention provide improved properties as compared to numerous prior art fabric laminates. Fabrics according to the invention can be used in medical fabric applications, such as sterilization wraps, surgical gowns and drapes, personal care and hygiene products, diapers, disposable training pants, bandages, disposable medical and industrial garments and in industrial products such as for filtration. The

fabrics of the invention avoid manufacturing complexities associated with many prior art fabrics. Thus the fabrics of the invention in many cases can lower the costs and substantially improve manufacturing efficiencies previously associated with composite elastic fabrics.

Brief Description of the Drawings

In the drawings which form a portion of the original disclosure of the invention:

Figure 1 schematically illustrates one preferred method and apparatus for manufacturing one preferred composite elastic nonwoven web from the combination of spunbonded elastomeric layers and an elastomeric meltblown web according to the invention; and

Figure 2 is a fragmentary perspective view of one embodiment of a composite elastic nonwoven fabric of the invention formed according to the process of Figure 1.

Detailed Description of the Invention

In the following detailed description of the invention, specific preferred embodiments of the invention are described to enable a full and complete understanding of the invention. It will be recognized that it is not intended to limit the invention to the particular preferred embodiments described, and although specific terms are employed in describing the invention, such terms are used in the descriptive sense for the purpose of illustration and not for the purpose of limitation. It will be apparent that the invention is susceptible to variation and changes as will become apparent from a consideration of the foregoing discussion and the following detailed description.

The various nonwoven webs used for forming the composite fabrics of this invention are elastomeric layers having elastic properties. As used herein and only for purposes of this application, the term

"elastomeric" is used with reference to nonwoven webs and fabrics, including elastomeric spunbonded webs and elastomeric meltblown webs, capable of substantial recovery, i.e. greater than about 75%, preferably greater than about 90% recovery, when stretched in an amount of about 30% at room temperature expressed as:

$$\% \text{ recovery} = (L_s - L_r)/(L_s - L_o) \times 100$$

where: L_s represents stretched length; L_r represents recovered length measured one minute after recovery; and L_o represents original length of material.

Figure 1 schematically illustrates one preferred method and apparatus for manufacturing one preferred composite elastic nonwoven web from the combination of spunbonded elastomeric webs and an inner meltblown elastomeric web according to the invention. In Figure 1, a spunbond apparatus is shown at 10 and is preferably a slot drawing apparatus as known in the art. The elastomeric spunbonded webs employed in this embodiment of the invention are preferably formed in accordance with the teachings of U.S. Patent Application Serial No. 07/829,923 of Gessner, et al.; filed February 3, 1992; and entitled "Elastic Nonwoven Webs and Method of Making Same", which is hereby incorporated in its entirety into this application by reference.

Slot drawing apparatus 10 includes a melt spinning section including a feed hopper 12 and an extruder 14 for the polymer. The extruder 14 is provided with a generally linear die head or spinneret 16 for melt spinning streams of substantially continuous filaments 18. The substantially continuous filaments 18 are extruded from the spinneret 16 and typically are quenched by a supply of cooling air (not shown). The filaments are directed to an attenuation slot 20 which includes downwardly moving attenuation air which can be supplied from forced air above the slot, vacuum below the slot, or eductively within the

slot, as known in the art. The attenuation slot may be separate from or integral with the drawing slot as also known in the art. The air and filaments exit the attenuation slot 20 and are collected on a forming wire 22 as a nonwoven spunbond web 24.

Advantageously, the filaments 18 are extruded from the spinneret 16 at a rate sufficient to provide drawn filaments at a spinning rate of about 100 to about 2000 meters per minute. The forming wire 22 is typically moved at a slower linear velocity than the spinning rate (linear velocity of the filaments) to increase the density and cover of the spunbond web 24. In a preferred embodiment, the filaments 18 are produced at a spinning rate of about 450 to about 1200 meters per minute. Drawing forces sufficient to provide a spinning rate in excess of 1200-2000 meters per minute are advantageously avoided because excess filament breakage can occur due to the elastic nature of polymer. Preferably the filaments of the spunbond web 24 have a denier per filament in the range less than about 50 denier per filament, more preferably from about 1 to about 10 denier per filament, and most preferably from about 2 to about 6 denier per filament.

Elastomeric spunbond layers are preferably produced by melt spinning substantially continuous filaments of a thermoplastic olefin-based elastomer. These olefinic elastomers are advantageously formed using metallocene polymerization catalysis and are commercially available as the EXACT resins from Exxon, which are linear low-density polyethylenes; and as CATALLOY resins from Himont, which are crystalline olefin, heterophasic copolymers including a crystalline base polymer fraction, i.e., block, and an amorphous copolymer fraction or block with elastic properties as a second phase blocked to the crystalline base polymer fraction via a semi-crystalline polymer fraction.

The EXACT resins come in multiple grades. Spunbond fabrics made from these polymers all have good extensibility. One big change in spunbond fabric properties with changing resin grades is the degree of recovery of the fabric. The higher density materials have less recovery. The lower density materials have good recovery, albeit not as good as some commercially available elastic materials. Properties of some of the currently available Exxon EXACT polymers are shown below in Table 1.

TABLE 1. PROPERTIES OF POLYMERS.

	RESIN GRADE (Manufacturer's Designation)					
PROPERTY	2004	2003	3017	4014	5004	5009
Density, g/cm^3	0.93	0.92	0.90	0.89	0.87	0.87
T_m°C	115.6	107.7	87.5	73.3	47.5	44.5
T_C°C	101.6	96.5	76.3	52.7	30.7	25.5
M.I. (dg/min)	28.7	31	25	31	19	18.2
GPC M_N	14.6	21.4	17.2	21.7	21.8	24.2
GPC M_W	44.4	45.5	43.2	45.2	47.8	51.7
MWD M_W/M_N	3.00	2.10	2.50	2.10	2.20	2.10

Spunbond fabrics spun from the above polymers also have differences in hand. The lowest density materials have a distinctly unfavorable rubbery hand. These materials are tacky and feel clammy to the skin. The medium density materials have a very soft, good feeling hand.

The presently preferred elastic spunbond fabric for use in the composites of the invention is made from EXACT 3017. The base spunbond material has the following mechanical properties, in a five cycle 100% elongation hysteresis test (machine direction only):

100% Elongation Test	40% Elongation Test
Cycle One Tensile, g/in: 640	Cycle One Tensile, g/in: 373
Cycle Five Tensile, g/in: 551	Cycle Five Tensile, g/in: 302
Permanent Set: 42%	Permanent Set: 18%

Basis Weight, g/m^2: 60
Elongation at Peak: 182%

Basis Weight, g/m^2: 60
Elongation at Peak: 182%

As indicated previously, thermoplastic primarily crystalline olefin block copolymers having elastic properties are also advantageously used to form spunbonds. These polymers are commercially available from Himont, Inc., Wilmington, Delaware, and are disclosed in European Patent Application Publication 0416379 published March 13, 1991, which is hereby incorporated by reference. The polymer is a heterophasic block copolymer including a crystalline base polymer fraction and an amorphous copolymer fraction having elastic properties which is blocked thereon via a semi-crystalline homo- or copolymer fraction. In a preferred embodiment, the thermoplastic primarily crystalline olefin polymer is comprised of at least about 60 to 85 parts of the crystalline polymer fraction, at least about 1 up to less than 15 parts of the semi-crystalline polymer fraction and at least about 10 to less than 39 parts of the amorphous polymer fraction. Advantageously, the primarily crystalline olefin block copolymer comprises 65 to 75 parts of the crystalline copolymer fraction, from 3 to less than 15 parts of the semi-crystalline polymer fraction, and from 10 to less than 30 parts of the amorphous copolymer fraction.

Preferably the crystalline base polymer block of the heterophasic copolymer is a copolymer of propylene and at least one alpha-olefin having the formula $H_2C{=}CHR$, where R is H or a C_{2-6} straight or branched chain alkyl moiety. Preferably, the amorphous copolymer block with elastic properties of the heterophasic copolymer comprises an alpha-olefin and propylene with or without a diene or a different alpha-olefin termonomer, and the semi-crystalline copolymer block is a low density, essentially linear

copolymer consisting substantially of units of the alpha-olefin used to prepare the amorphous block or the alpha-olefin used to prepare the amorphous block present in the greatest amount when two alpha-olefins are used.

Other elastomeric polymers which can be used to form elastomeric spunbonds include polyurethane elastomers; ethylene-polybutylene copolymers; poly(ethylene-butylene) polystyrene block copolymers, such as those sold under the trade names Kraton G-1657 and Kraton G-1652 by Shell Chemical Company, Houston, Texas; polyadipate esters, such as those sold under the trade names Pellethane 2355-95 AE and Pellethane 2355-55DE by Dow Chemical Company, Midland, Michigan; polyester elastomeric polymers; polyamide elastomeric polymers; polyetherester elastomeric polymers, such as those sold under the trade name Hytrel by DuPont Company of Wilmington, Delaware; ABA triblock or radial block copolymers, such as Styrene-Butadiene-Styrene block copolymers sold under the trade name Kraton by Shell Chemical Company; and the like. Also, polymer blends of elastomeric polymers, such as those listed above, with one another and with other thermoplastic polymers, such as polyethylene, polypropylene, polyester, nylon, and the like, may also be used in the invention. Those skilled in the art will recognize that elastomer properties can be adjusted by polymer chemistry and/or by blending elastomers with non-elastomeric polymers to provide elastic properties ranging from fully elastic stretch and recovery properties to relatively low stretch and recovery properties. Preferably a low to medium elastic property elastomer is used in the spunbond process as evidenced by a flexural modulus ranging from about 200 psi to about 10,000 psi, and preferably from about 2000 psi to about 8000 psi.

The preferred elastomeric spunbonded fabrics have a desirable soft hand and elastomeric properties such that the spunbonds exhibit a root mean square (RMS) recoverable elongation of at least about 75% in both the machine direction (MD) and the cross direction (CD) after 30% elongation and one pull. RMS average recoverable elongations are calculated from the formula: RMS average recoverable elongation = $[\frac{1}{2}(CD^2 + MD^2)]^{\frac{1}{2}}$; wherein CD is recoverable elongation in the cross direction and MD is the recoverable elongation in the machine direction. Preferably, the fabrics have at least about a 70% RMS recoverable elongation after two such 30% pulls. More preferably, the fabrics comprise the thermoplastic elastomer in an amount sufficient to give the fabric at least about a 65% RMS recoverable elongation based on machine direction and cross direction values after 50% elongation and one pull, and even more preferably at least about 60% RMS recoverable elongation after two such pulls. Preferably the elastomer constitutes at least about 50%, most preferably at least about 75%, by weight of the filament. Elastic properties of fabrics of the invention are measured using an Instron Testing apparatus, using a 5 inch gauge length and a stretching rate of 5 inches per minute. At the designated stretch or percent elongation value, the sample is held in the stretched state for 30 seconds. The elongation of the sample is then decreased at the same rate of 5 in./min. until the original 5 inch gauge length is obtained. The percent recovery can then be measured.

Returning now to Figure 1, the elastomeric spunbond web 24 is thus formed on, and conveyed by, forming screen 22 in the longitudinal direction as indicated by the arrows. The spunbond web is conveyed to a conventional meltblowing apparatus 26. The meltblowing apparatus 26 forms a meltblown elastomeric fibrous stream 28 which is deposited onto the moving

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spunbonded web 24 to form a two-layered structure 30. Meltblowing processes and apparatus are known to the skilled artisan and are disclosed, for example, in U.S. Patent 3,849,241 to Buntin, et al. and U.S. 4,048,364 to Harding, et al.

The meltblowing process involves extruding a molten thermoplastic elastomer (which can be formed of the elastomers described above in regard to the elastomeric spunbonded web 24), through fine capillaries into fine filamentary streams. The filamentary streams exit the meltblowing spinneret head where they encounter converging streams of high velocity heated gas 32, typically air, supplied from a pair of converging nozzles. The converging streams of high velocity heated gas attenuate the polymer streams and break the attenuated streams into meltblown fibers.

As noted above, the elastomeric meltblown web can be formed using any of the elastomeric polymers described above with regard to the spunbonded web. As will be appreciated by the skilled artisan, the particular polymers selected for forming each of the webs can be selected based upon the particular end properties desired for the elastic composite. For example, the elastomeric meltblown web is preferably formed of a diblock, triblock, radial and star copolymers based on polystyrene (S) and unsaturated or fully hydrogenated rubber blocks when good elastic recovery properties are to be imparted to the composite fabric by the meltblown web. The rubber block can consist of butadiene (B), isoprene (I), or the hydrogenated version, ethylene-butylene (EB). For example, S-B, S-I, S-EB, as well as S-B-S, S-I-S, S-EB-S linear block copolymers can be used. Typically when used one or more of the diblock copolymers are blended with the triblock or radial copolymer elastomers. Preferred thermoplastic elastomers of this type can include the KRATON polymers sold by Shell Chemical

Company or the VECTOR polymers sold by DEXCO. Similarly, the elastomeric meltblown web can be formed from the EXACT or CATALLOY resins described above to provide particularly desirable composites having excellent drape, softness and conformability properties.

The elastomeric webs can also be prepared from blends of thermoplastic elastomers with other polymers such as polyolefin polymers, e.g. blends of Kraton polymers with polyolefins such as polypropylene and polyethylene, and the like. These polymers can provide lubrication and decrease the melt viscosity, allow for lower melt pressures and temperatures and/or increase throughput, and provide better bonding properties too. In a preferred embodiment of the invention, such other polymers can be included in the blend as a minor component, for example in an amount of between about 5% by weight up to 50% by weight, preferably from about 10 to about 30% by weight of the mixture. Suitable thermoplastic polymers, include, in addition to the polyolefin polymers, poly(ethylene-vinyl acetate) polymers having an ethylene content of up to about 50% by weight, preferably between 15 and 30% by weight and copolymers of ethylene and acrylic acid or esters thereof, such as poly(ethylene-methyl acrylate) or poly(ethylene-ethyl acrylate) wherein the acrylate acid or ester component ranges from about 5 to about 50% by weight, preferably from about 15 to about 30% by weight. In addition polystyrene and poly(alpha-methyl styrene) can be used.

The two layer structure is advanced in the machine direction by forming screen 22. A second spunbonding apparatus 40, constructed the same as spunbonding apparatus 10, forms a curtain of filaments 42 which are deposited as a second elastomeric spunbond fibrous layer onto the composite structure 30 to form a three-layered structure 44. The three layered

structure 44 is then conveyed to a thermal treatment station 46.

A preferred embodiment of thermal treatment station 46 is illustrated in Figure 1 as a pair of heated calender rolls 48 and 50. The operating temperature of heated rolls 48 and 50 should be adjusted to a surface temperature such that the spunbond fibers are heated sufficiently to soften fibers in at least one of the fibrous layers for bonding the composite web into a unitary structure. On the other hand, the heat transfer conditions are advantageously maintained to avoid or minimize degradation of physical properties, e.g., stretch, barrier, etc., as can result from excessively high temperatures and/or pressures. In advantageous embodiments of the invention the elastomer resin forming either the spunbond or meltblown layer is selected to have a melting point of at least 5°C, preferably at least 10°C, less than the melting point of the other type of layer. This allows use of low temperature, low pressure calender conditions for bonding of the composite without melting of fibers of one of the meltblown or spunbonded layers, as desired.

The pattern of the calender rolls may be any of those known in the art, including point bonding patterns, helical bonding patterns, and the like. The term point bonding is used herein to be inclusive of continuous or discontinuous pattern bonding, uniform or random point bonding, or a combination thereof, all as are well known in the art. Preferably, the webs are joined together by a multiplicity of discrete thermal bond sites distributed substantially throughout the composite nonwoven fabric.

A thermally-bonded composite elastic fabric 52 is removed from the nip of the heated rolls 48 and 50 and wound by conventional means onto roll 54. The composite elastic fabric 52 can be stored on roll 54 or

immediately passed to end use manufacturing processes, for example for use in sterile wraps, surgical fabrics, bandages, diapers, disposable undergarments, personal hygiene products and the like. Blocking of the layers of the composite on the roll can be avoided in accordance with the invention by employing resins having a very narrow molecular weight distribution for forming the spunbond, such as the linear low density polyethylene elastomer resins commercially available from Exxon discussed previously. Narrow molecular weight distribution minimizes the presence of very low molecular weight polymer fragments which can act like plasticizers and/or adhesives and cause blocking of adjacent layers on a roll.

The method illustrated in Figure 1 is susceptible to numerous preferred variations. For example, although the schematic illustration of Figure 1 shows spunbond webs being formed directly during the in-line process, it will be apparent that one or both of the webs can be preformed, lightly bonded fabrics, and supplied as rolls of preformed fabrics. Similarly, although the elastomeric meltblown web is shown being formed in-line, it too can be supplied as a roll of a preformed web. Although Figure 1 illustrates use of two fibrous spunbond webs, one above and one below the elastomeric meltblown web, only a single spunbond web can be employed or more than two spunbond webs can be employed. Similarly, one or more meltblown webs can be used.

In addition, the spunbond web or webs may be bonded or joined to the elastomeric meltblown web in any of the ways known in the art so long as the meltblown and spunbonded webs remain as substantially discreet layers in the final composite fabric. Thus the heated calender rolls 48 and 50 can, in other embodiments of the invention, be replaced by other bonding zones, for example in the form of an ultrasonic

welding station or the like. It is also possible to achieve bonding through the use of an appropriate bonding agent, i.e., an adhesive.

Figure 2 is a fragmentary perspective view of one embodiment of a nonwoven web of the invention formed according to the process of Figure 1. As shown, the composite fabric is a unitary structure including elastomeric spunbond layers 24 and 42 having elastomeric meltblown web 28 sandwiched between the two spunbonded layers. The three layer structure is joined into a unitary product 52 by a multiplicity of discrete thermal bond sites 60 distributed substantially throughout the composite nonwoven fabric. The point bonds may be formed on one or both sides of the composite fabric.

The composite elastic fabrics of the invention provide improved aesthetics, such as desirable hand and cover, flexibility and drape, to the laminate, as contrasted to prior art laminates which typically are stiff, inflexible and boardy. Further, conformability and drape are imparted to the composite fabrics of the invention while substantial barrier and/or porosity properties can be maintained. The composite also exhibits good strength properties without requiring reinforcing layers of limited extensibility.

Fabrics according to the invention can be used in medical fabric applications, such as sterilization wraps, surgical gowns and drapes, personal care and hygiene products, diapers, disposable training pants, bandages, shoe covers and other disposable skid resistent products, disposable medical and industrial garments and in industrial products such as for filtration. The elastic composite fabrics of the present invention of the invention can be used as medical barrier fabrics. Conformability of the SMS laminate can be substantially improved according to

this aspect of the invention. Among the known uses of SMS fabrics, the use of these fabrics as sterile wraps is of substantial significance. Because an elastic SMS fabric is capable of conforming to a wrapped article, the elastic SMS fabric of the invention provides significant advantages and benefits. Moreover, when the elastic fabric is stretched as it is wrapped around an article, the fabric can exhibit "self opening" capabilities when the wrap is removed from the article. This, in turn, can eliminate or minimize the need or possibility of incidental contact with the sterile article during removal of the sterile wrap. The fabrics are also desirable for use as surgical fabrics, such as surgical gowns, because of their ability to conform to body shapes and to allow freedom of body movement, and surgical drapes, because of the their good flexibility and drapeability.

An added benefit of the present invention is that the composite fabrics used in sterile medical applications can be sterilized using gamma radiation. Conventional SMS type barrier fabrics are limited to the types of sterilizations which can be used. Sterilization by gamma radiation has been found to be unsuitable for many known medical barrier fabrics formed of conventional grades of polypropylene which are sensitive to degradation by gamma radiation. Fabrics produced from such polymers tend to lose strength over time, becoming brittle as a result of gamma radiation treatment. Also the instability of the polymers to irradiation results in the generation of distasteful odors in the product. This instability is believed to result from the alpha olefin structure of polypropylene, which is subject to attack and degradation by free radicals generated by radiation processes.

In contrast to polypropylene, the polyethylene based EXACT resins have fewer alpha-olefin

sites subject to free radical attack. In addition, these polymers have high levels of polymethylene chains which tend to crosslink in the presence of free radicals. Consequently when subjected to gamma radiation, the EXACT resins are predominantly crosslinked. Although the CATALLOY polymers have a greater alpha-olefin content; the predominant effect of gamma radiation is still crosslinking due to presence of significant amounts of polymethylene chains.

As will be apparent from the foregoing although the elastomeric nonwoven composite fabrics of the invention are advantageously formed entirely from elastomeric layers, the fabric can be laminated or otherwise joined to other layers, fabrics and materials for the formation of various useful articles, such as diapers, disposable undergarments and the like. As is well known in the art, a primary function of absorbent personal care products, such as disposable diapers, adult incontinence pads, sanitary napkins, and the like, is to rapidly absorb and contain body exudates to prevent soiling, wetting, or contamination of clothing or other articles. For example, disposable diapers generally comprise an impermeable backsheet layer, an absorbent core layer, and a topsheet layer to allow rapid flow into the absorbent core. Elasticized leg flaps and barrier leg cuffs can also be added to the absorbent personal care product construction to improve containment and prevent leakage.

Typically, disposable diapers and related articles leak when body exudates escape out through gaps between the article and the wearer's legs or waist. Elastic components, such as those comprising the elastic laminates of the invention, can provide absorbent articles with an improved degree of fit to the wearer's legs or body and thus can reduce the propensity for leaking.

The elastic nonwoven composite fabrics according to the invention can advantageously be used as a coverstock layer, such as a topsheet or backsheet, in a disposable personal care product, such as a disposable diaper. In one embodiment of this aspect of the invention, an elastic nonwoven fabric according to the invention is used as a backsheet layer of a diaper. The elastic nonwoven fabric alone can provide a barrier impervious to the passage of liquid, yet is still breathable. Alternatively, the fabric can be given barrier properties by any of the ways known in the art. For example, additional barrier properties can be obtained by laminating a polyolefin film, such as a polyethylene or a polypropylene film, to the elastic nonwoven fabric, by point or continuous bonding of the web and the film via either smooth or patterned calender rolls. The lamination may also be achieved by the use of an appropriate bonding agent.

The elastic nonwoven laminate is then combined with an absorbent body, such as a preformed web of wood pulp, located in a facing relationship with the inner surface of a substantially liquid permeable topsheet layer to produce a diaper. Wood pulp may be included in the absorbent body, preferably by incorporating the wood fiber from a hammer milled water laid web or from an air laid web which may contain staple textile fibers, such as cotton, reconstituted cellulose fibers, e.g., rayon and cellulose acetate, polyolefins, polyamides, polyesters, and acrylics. The absorbent core may also include an effective amount of an inorganic or organic high-absorbency (e.g., superabsorbency) material as known in the art to enhance the absorptive capability of the absorbent body. The elastic nonwoven fabric and the absorbent body may be combined in any of the ways known in the art.

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The elastic fabrics of the invention can also be used as a topsheet layer in a diaper. The topsheet layer advantageously permits liquid to rapidly flow through it into the absorbent core (referred to in the art as "rapid strike through") but does not facilitate re-transmission of liquid back from the absorbent core to the body side of the topsheet (referred to in the art as "rewet resistance"). To achieve a desirable balance of strike through and rewet resistance, the elastic nonwoven composite fabrics of the invention can be treated to impart hydrophilic characteristics thereto. For example, the nonwoven elastic composite fabric of the invention or the surface thereof can be treated with a surfactant as are well known in the art, such as Triton X-100 or the like.

The elastic nonwoven fabric produced as described above is then combined with an absorbent body, in facing relationship with the inner surface of a substantially liquid impermeable backsheet layer. The elastic nonwoven composite fabric may be combined with the absorbent body and the substantially liquid impermeable backsheet layer in any of the ways known in the art, such as gluing with lines of hot-melt adhesive, seaming with ultrasonic welding, and the like.

The elastic laminates of the invention are also useful in the leg flaps and/or waist band areas of absorbent products to produce a soft, cloth-like elastic structure. Because the laminates of the invention exhibit both elastic and fluid barrier properties, in these end uses, the laminates can serve dual purposes of improving garment fit and over all fluid containment. The elastic nonwoven webs of this invention can thus be used to replace strands of elastic filaments, heat shrinkable films, and the like, to produce a product having a leak resistant fit with

improved softness and protection from red marks on the wearer's legs or waist.

Fabrics of the present invention can also be used in filtration applications. These fabrics can be provided with controllable filtration properties such that filtration ability can be changed simply by varying elongation of the fabric. This can be extremely useful in industrial systems because as a filter becomes clogged from trapped particulates, the fabric can be slightly elongated and used for a longer time.

In addition, the composite elastic nonwoven fabrics of the invention can also include other elastomeric layers. Such elastomeric layers include elastomeric nets and elastomeric nonwoven webs formed from staple fibers and/or yarns and which have been coated or impregnated with an elastomeric material and consolidated into a web by adhesive and thermal bonding. Although in advantageous embodiments of the invention, the meltblown elastomeric web typically has lower strength than the elastomeric spunbonded web or webs, it will be apparent that in other advantageous embodiments, the meltblown web or webs can have a greater strength than the spunbonded web or webs, particularly when the latter are included primarily to improve tactile properties of the laminate.

The following examples are provided to illustrate the fabrics of the invention and processes for making them but are not to be construed as limitations on the invention.

EXAMPLE 1

POINT BONDED ELASTIC COMPOSITE

A meltblown web of 20 grams per square yard basis weight was prepared by meltblowing Exact 4014 linear low density polyethylene resin obtained from Exxon Corporation. A lightly bonded continuous filament web was prepared from the same resin on a

Reicofil spunbonded machine. The basis weight of this fabric was 50 grams per square yard. A sample of the meltblown web was placed between two layers of the spunbonded fabric. This "sandwich" was passed between the nip rolls of a thermobonding calender which had been outfitted with one point bonding roll (16% bond area) and one smooth roll. The temperature of both rolls was 65°C. The resulting fabric was very firmly bonded and had the mechanical properties described in Table 2 below. Shrinkage in both directions occurred during the bonding process.

TABLE 2

MECHANICAL PROPERTIES
OF
ELASTIC SPUNBOND/MELTBLOWN LAMINATES

	9214-G	9214-H
Meltblown Polymer (manufacturer's designation)	4014*	4013*
Basis Weight - g/sq. yd.	151	137
Tensile Strength - MD (g/in)	1818	1465
Tensile Strength - CD	1161	826
Elongation at Max. - MD Stress (%)	266	248
Elongation at Max. - CD Stress (%)	335	267
Permanent Set (%)[1] - MD	10-15	10-15
Permanent Set (%)[1] - CD	10-15	10-15
Stress Relaxation[2] - MD	39	39
Stress Relaxation[2] - CD	43	43
Stretch Creep (under stress)[3] - MD	25	17
Stretch Creep (under stress)[3] - CD	75	58
Stretch Creep (stress removed)[4] - MD	14	12
Stretch Creep (stress removed)[4] - CD	50	37

* EXACT resin designations of Exxon
-1 5 cycle hysteresis test at 100 percent elongation, crosshead speed 12 in/min., gauge length of 2 in., sample width 1 inch.
-2 Sample held for 5 min. at 50% elongation.
-3 Elongation after subjecting sample to 100 g/in load for 30 min at 100°F, measured with load still applied.
-4 Elongation measured 30 seconds after load removed following stretch Creep test (under stress).

The invention has been described in considerable detail with reference to its preferred embodiments. It will be apparent that numerous variations and modifications can be made without departing from the spirit and scope of the invention as described in the foregoing detailed specification and as defined in the following claims.

THAT WHICH IS CLAIMED IS:

1. A composite elastic nonwoven fabric formed from the combination of a plurality of discrete cooperative elastic layers comprising:

a first elastomeric spunbonded web comprising a plurality of substantially continuous filaments; and

a second elastomeric fibrous web comprising a plurality of meltblown fibers,

said elastomeric spunbonded web and said elastomeric meltblown web being joined together to form a unitary coherent elastomeric fabric.

2. The composite elastic nonwoven fabric according to Claim 1 wherein said first elastomeric spunbonded web and said second elastomeric meltblown web have different elastic properties, and wherein composite elastic fabric has a combination of different elastic properties.

3. The composite elastic nonwoven fabric according to Claim 1 further comprising a second elastomeric spunbonded nonwoven web comprising a plurality of substantially continuous filaments, said elastomeric meltblown web being disposed between said first and second elastomeric spunbonded webs.

4. The composite elastic nonwoven fabric according to Claim 1 wherein said elastomeric spunbonded web and said elastomeric meltblown web are joined together by thermal bonding.

5. The composite elastic nonwoven fabric according to Claim 1 wherein said elastomeric spunbonded web and said elastomeric meltblown web are joined together by a multiplicity of discrete thermal bond sites distributed substantially throughout said composite nonwoven fabric.

6. The composite elastic nonwoven fabric according to Claim 1 wherein said meltblown web comprises an elastomeric linear low density polyethylene polymer.

7. The composite elastic nonwoven fabric according to Claim 1 wherein said meltblown web comprises a crystalline olefin, heterophasic copolymer including a crystalline base polymer block, and an amorphous copolymer block with elastic properties as a second phase blocked to the crystalline base polymer block via a semi-crystalline polymer block.

8. The composite elastic nonwoven fabric according to Claim 1 wherein said spunbonded web comprises an elastomeric linear low density polyethylene polymer.

9. The composite elastic nonwoven fabric according to Claim 1 wherein said spunbonded web comprises a crystalline olefin, heterophasic copolymer including a crystalline base polymer block, and an amorphous copolymer block with elastic properties as a second phase blocked to the crystalline base polymer block via a semi-crystalline polymer block.

10. The composite elastic nonwoven fabric according to Claim 1 wherein said meltblown web comprises an elastomer selected from the group consisting of polyurethanes, ABA block copolymers, ethylene-polybutylene copolymers, poly(ethylene-butylene) polystyrene block copolymers, polyadipate esters, polyester elastomeric polymers, polyamide elastomeric polymers, polyetherester elastomeric

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polymers, polyetheramide elastomeric polymers, elastomeric linear low density polyethylene polymers, primarily crystalline heterophasic olefin copolymers, and blends thereof with at least one other elastomeric or non-elastomeric polymer.

11. The composite elastic nonwoven fabric according to Claim 1 wherein said spunbonded web comprises an elastomer selected from the group consisting of polyurethanes, ABA block copolymers, ethylene-polybutylene copolymers, poly(ethylene-butylene) polystyrene block copolymers, polyadipate esters, polyester elastomeric polymers, polyamide elastomeric polymers, polyetherester elastomeric polymers, polyetheramide elastomeric polymers, elastomeric linear low density polyethylene polymers, primarily crystalline heterophasic olefin copolymers, and blends thereof with at least one other elastomeric or non-elastomeric polymer.

12. A composite elastic nonwoven fabric formed from the combination of a plurality of cooperative elastic webs comprising:

first and second elastomeric spunbonded webs comprising a plurality of substantially continuous filaments;

an elastomeric meltblown web comprising a plurality of meltblown fibers, and having different elastic properties as compared to said elastomeric spunbonded webs, said elastomeric meltblown web being disposed between said first and second elastomeric spunbonded webs; and

a multiplicity of discrete thermal bond sites distributed substantially throughout said composite nonwoven fabric to form a unitary coherent elastomeric fabric having a combination of different elastic properties.

13. A process for producing a composite elastic nonwoven fabric, comprising:

preparing a plurality of discrete elastomeric nonwoven webs comprising a first elastomeric spunbonded web comprising a plurality of substantially continuous filaments and a second elastomeric fibrous web comprising a plurality of meltblown fibers; and

joining said plurality of nonwoven elastomeric webs cooperatively together to form a unitary coherent elastomeric fabric.

14. The process according to Claim 13 wherein said first elastomeric spunbonded web and said second elastomeric meltblown web have different elastic properties, and wherein composite elastic fabric has a combination of different elastic properties.

15. The process according to Claim 13 further comprising the step of providing a second elastomeric spunbonded nonwoven web comprising a plurality of substantially continuous filaments, and sandwiching said elastomeric meltblown web between said first and second elastomeric spunbonded webs.

16. The process according to Claim 13 wherein said joining step is accomplished by thermal bonding.

17. The process according to Claim 13 wherein said joining step comprises forming a multiplicity of discrete thermal bond sites distributed substantially throughout said composite nonwoven fabric.

18. The process according to Claim 13 wherein said meltblown web comprises an elastomeric linear low density polyethylene polymer.

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19. The process according to Claim 13 wherein said meltblown web comprises a crystalline olefin, heterophasic copolymer including a crystalline base polymer block, and an amorphous copolymer block with elastic properties as a second phase blocked to the crystalline base polymer block via a semi-crystalline polymer block.

20. The process according to Claim 13 wherein said spunbonded web comprises an elastomeric linear low density polyethylene polymer.

21. The process according to Claim 13 wherein said spunbonded web comprises a crystalline olefin, heterophasic copolymer including a crystalline base polymer block, and an amorphous copolymer block with elastic properties as a second phase blocked to the crystalline base polymer block via a semi-crystalline polymer block.

22. The process according to Claim 13 wherein said meltblown web comprises an elastomer selected from the group consisting of polyurethanes, ABA block copolymers, ethylene-polybutylene copolymers, poly(ethylene-butylene) polystyrene block copolymers, polyadipate esters, polyester elastomeric polymers, polyamide elastomeric polymers, polyetherester elastomeric polymers, polyetheramide elastomeric polymers, elastomeric linear low density polyethylene polymers, primarily crystalline heterophasic olefin copolymers, and blends thereof with at least one other elastomeric or non-elastomeric polymer.

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23. The process according to Claim 13 wherein said spunbonded web comprises an elastomer selected from the group consisting of polyurethanes, ABA block copolymers, ethylene-polybutylene copolymers, poly(ethylene-butylene) polystyrene block copolymers, polyadipate esters, polyester elastomeric polymers, polyamide elastomeric polymers, polyetherester elastomeric polymers, polyetheramide elastomeric polymers, elastomeric linear low density polyethylene polymers, primarily crystalline heterophasic olefin copolymers, and blends thereof with at least one other elastomeric or non-elastomeric polymer.

24. A process for producing a composite elastic nonwoven fabric, comprising:

preparing a plurality of elastomeric nonwoven layers comprising first and second elastomeric spunbonded web comprising a plurality of substantially continuous filaments and an elastomeric fibrous web comprising a plurality of meltblown microfibers sandwiched between said first and second elastomeric spunbonded webs; and

joining said plurality of nonwoven elastomeric webs by forming a multiplicity of discrete thermal bond sites distributed substantially throughout said composite nonwoven fabric to form a unitary coherent elastomeric fabric.

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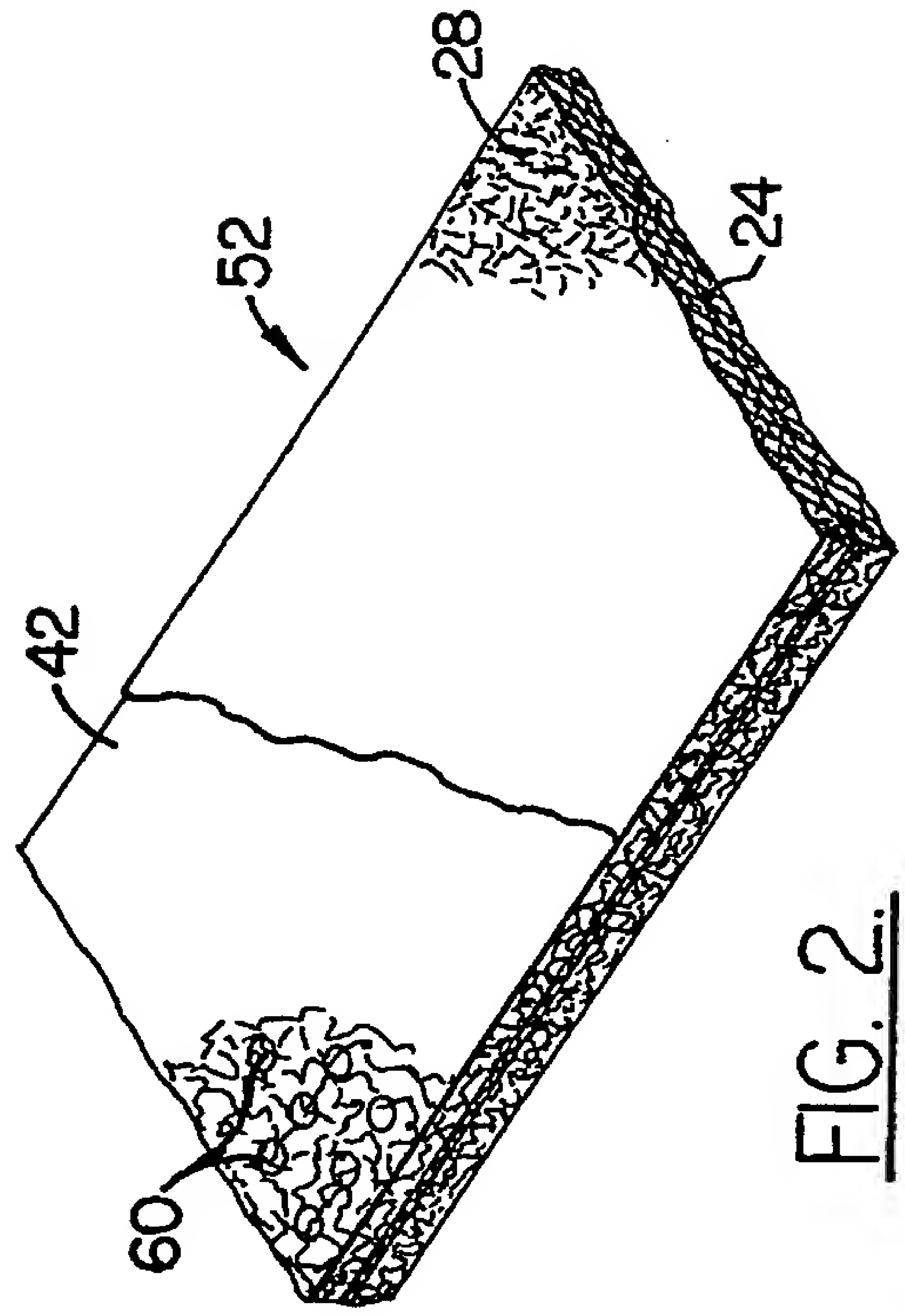

FIG. 2.

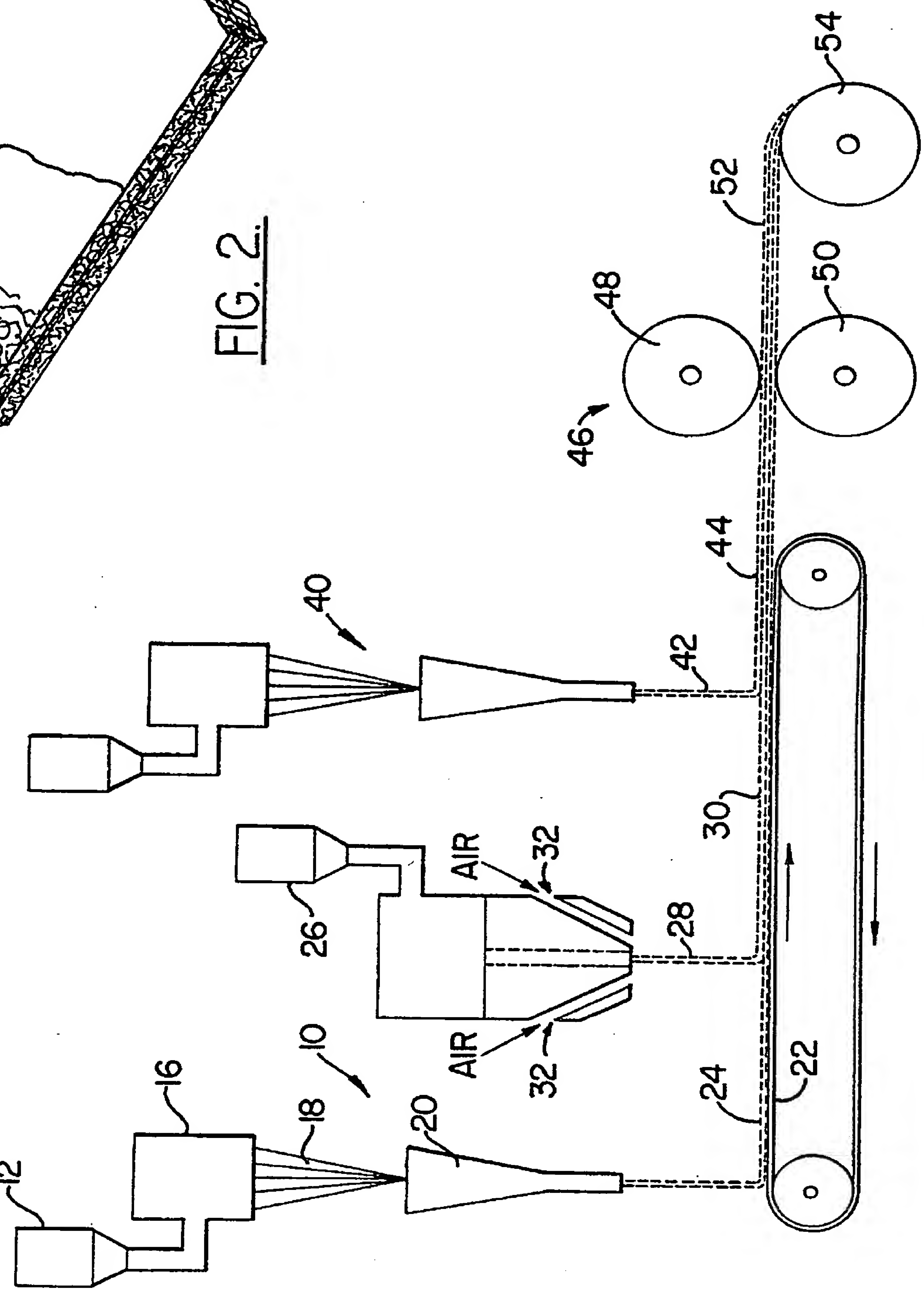

FIG. 1.